

NON-PROVISIONAL PATENT APPLICATION

FOR

UNITED STATES LETTERS PATENT

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FOR

**UNIVERSAL TRANSPORTABLE COMPRESSED AIR FOAM
FIRE FIGHTING SYSTEM**

REFERENCE TO RELATED APPLICATION

This Non-Provisional Patent Application is based upon U.S. Provisional Patent Application Serial No. 60/409,717 filed September 10, 2002, and hereby claims the
5 benefit of the embodiments therein and of the filing date thereof.

FIELD OF THE INVENTION

This invention relates to the field of fire fighting, and more particularly, to
10 compressed air foam systems (CAFS) for controlling the flow of fire fighting fluids which employ foam-producing additives to water to be delivered by a hose from a pressurized source, such as a pump, a fire hydrant, or from such other sources, such as a tank, a stream or a lake.

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BACKGROUND OF THE INVENTION

There are many situations where it would be desirable to have a compact, relatively portable fire-fighting system readily available, particularly in forest or brush areas or in remotely located neighborhoods where full scale fire-fighting equipment is not readily available or accessible. Such a compact system should, to the extent possible, make use of the most advanced fire-fighting technology available.

The use of foam additives to water in fighting fires is well recognized as a major advance in improving the effectiveness in retarding ignition, extinguishing blazes, preventing re-ignition of burnable materials, and in indicating a coverage in both airborne drops and ground operations. Foam is particularly suited for use in forest or brush areas where it will also act as a wetting agent, exhibiting good cooling capability by blanketing burnable materials, and reducing smoke by the blanketing effect.

This system employs our previously patented foam mixing system, which is the subject of U.S. Patent 5,009,244, assigned to the assignee of the present patent application, which discloses a system for mixing foam concentrate, such as a product of Ansul Wormold Corp. of Marionette, Wisconsin, sold under the trademark ANSUL, with water in such a way that the precise desired proportion of foam concentrate is mixed with water irrespective of the quantity of water supplied to fight a fire. A significant element of this system is a differential pressure valve, the subject of U.S. Patent 5,165,442, which is also assigned to the assignee of the present application. Both of the above patents are hereby incorporated by reference.

- Fire fighters are concerned with the ratio of foam concentrate to water and also to the ratio of water/foam concentrate to air. If the foam concentrate provided is too low (below about .2%), this will result in pulsations (water slugs) in the hose. This is because there is not enough foam concentrate in the solution to form foam in the hose.
- 5 A somewhat higher ratio will yield a "wetter" appearing foam. A still higher ratio will yield a "drier" appearing foam. Varying degrees of dryness or wetness are appropriate for combating different types of fires.

Because the ratio of air to water/foam solution is recognized as being very important to getting the desired type of foam output, other systems have used separate

10 flow meters for air and for the water/foam concentrate mix. This arrangement is difficult to operate because it leaves one operator, the engineer, juggling the air and water/foam valves in an attempt to produce the desired output at the end of the hose, while the second operator, the firefighter, at the end of the hose may well be out of sight and out of earshot. So, although the second operator might recognize that the ratio was not

15 what was needed (more or less water/foam concentrate in proportion to air), he might have difficulty conveying to the operator the need for and the kind of change needed for controlling the flow.

It is, therefore, an object of the present invention to provide a compressed air foam fire-fighting system having controls capable of setting and maintaining desired

20 ratios of water/foam concentrate to compressed air.

It is another object of the present invention to provide a fire-fighting system incorporating the above objective, and in which the entire system is built into a framework small enough to fit in the bed of a typical full size pick-up truck.

It is a further object of the present invention to provide a fire-fighting system incorporating the above objectives and in which the ratio of foam concentrate to water is maintained irrespective of a volume of water delivered to the system.

It is a still further object of the present invention to provide a fire-fighting system
5 incorporating the above objectives and which is capable of delivering water, water/foam concentrate, water/foam concentrate mixed with compressed air and air alone.

Other objects and advantages will become apparent from consideration of the following specification taken in connection with the accompanying drawings.

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BRIEF SUMMARY OF THE INVENTION

This invention involves a universal fire fighting system, which is designed to be easily transportable by fire fighting personnel to a fire scene where the use of compressed air, foam/water fluids, as well as water alone or aspirated foam/water fluid, is used. The water may be supplied by a portable or fixed tank, a hydrant, or from another water source, such as a lake, stream or a swimming pool

The system, which can be carried on a pick-up truck, includes two small internal combustion engines, one of which drives a water pump, which may be connected to an integral tank or another water source and the other, which drives the air compressor for the system. Each engine has separate, independent controls. A control panel accessible at the rear of the pick-up truck contains controls for the engines, such as ignition and starter switches and choke and throttle controls. A number of gauges are included and switches for controlling the rate of flow of water, water/foam concentrate or compressed air. Valves are included for controlling water input, water or aspirated foam output, or compressed air/foam or air only outputs and a water drain line.

The patented foam mixing system of U.S. Patent 5,009,244 includes a metering valve which can be positioned or set to provide a precisely metered proportion of foam concentrate to water. A differential pressure valve applies discharge water pressure to the foam concentrate as a function of the flow through the main water line. In this manner, the system acts to maintain the desired proportion of foam concentrate to water irrespective of the volume of water delivered. Where only a water/foam solution is desired, this solution is supplied to a specific discharge conduit, including a two-way

valve.

When it is desired to combine the water/foam solution with air, the two-way valve controlling the output of water or water/foam solution is closed and the water/foam solution from the differential pressure valve is supplied to a foam solution metering valve which includes a movable plate having a plurality of ports, each calibrated to a different desired flow rate. The output of the foam solution-metering valve is then fed to an air injection venturi that includes ports for the injection of air into the foam solution from the foam solution-metering valve.

Air, under a substantial known pressure, is supplied by an engine-driven compressor and is fed to an air metering valve which includes a movable plate having a plurality of ports calibrated to supply compressed air in measured quantities at a known pressure. This selected airflow is connected to the air injection venturi which includes a series of ports at the throat of the venturi through which the air is injected. Thus, it will be understood that with precisely calibrated ports in both the foam solution metering valve and the air valve, the ratio of foam solution to air is controlled and maintained, and the system operators can rely on the ratio remaining and the system operators can rely on the ratio remaining as selected.

The modes of operation of this system are:

1. to supply water at the desire flow rate, either
 - a) from a self-contained tank or a tank on an associated vehicle; or
 - b) from an external source, such as a lake, stream, or swimming pool;
2. to supply a controlled ratio of foam concentrate mixed with water, which ratio remains essentially the same irrespective of the rate of water flow

- selected;
3. to supply controlled ratios of compressed air mixed with foam concentrate and water; and
 4. to supply compressed air only.

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BRIEF DESCRIPTION OF THE DRAWINGS

This invention may be more clearly understood from the following detailed description and by reference to the drawings in which:

- 5 Fig. 1 is a perspective view of a truck-mounted system of this invention;
- Fig. 2 is a schematic block diagram of this invention;
- Fig. 3 is a schematic drawing of the foam supply system of Fig. 2 on an enlarged scale;
- Fig. 4 is an exploded view of the foam selector metering valve;
- 10 Fig. 5 is a plan view of the metering disk of Fig. 4;
- Fig. 6 is a vertical sectional view of the foam selector metering valve of Fig. 4;
- Fig. 7 is a perspective view of the foam selector metering valve of Figs. 5-7;
- Fig. 8 is a vertical sectional view of the air metering valve;
- Fig. 9 is a sectional view taken along line 9-9 of Fig. 8;
- 15 Fig. 10 is a vertical sectional view of the air injection venturi of the invention;
- Fig. 11 is a sectional view taken along line 11-11 of Fig. 10; and
- Fig. 12 is a front elevational view of the control panel of the invention.

DETAILED DESCRIPTION

Referring now to Fig. 1, applicants' fire fighting system **10** is shown carried in the bed of a pick-up truck **PT**. The system **10** is a complete integrated system mounted on 5 and secured to a frame and includes a control panel **11** readily accessible from the back of the pick-up. Also carried in the bed of pick-up truck **PT** are a water tank **12** and a hose reel **14**. All inlet and outlet port valves are located on the control panel.

Fig. 2 is a schematic block diagram of the system **10** in which engine **E1** drives a water pump **18**, which is connected to water tank **12** through a pipe **19** and a two-way 10 valve **21**. Valve **21**, in one position, directs water directly from tank **12** to pump **18**; in its other position, it connects pump **18** with an input line (suction) **27** including a valve **36** for drawing water from an outside source which could be a lake, hydrant, swimming pool or a water truck. Fire fighting water from whatever source is pumped past a check 15 valve **68** to a differential pressure valve **17**, which corresponds to the differential pressure valve of U.S. Patent 5,009,244 referred to above and which is incorporated by reference and attached to this application. Differential pressure valve **17** maintains a pre-set ratio of foam concentrate to water supplied despite wide variations in flow rate of the mixture.

Foam is supplied from a bladder tank **42** which incorporates a flexible bladder **44** 20 containing a Class A foam concentrate, such as the agents sold under the trademark Sylvex of the Ansul Company of Marionette, WI. Bladder **44** is contained within tank **42** such that it is surrounded by water, which is connected to tank **12** through a water conduit **46** from a three-way selector valve **31** in line with differential pressure valve **17**.

The three-way selector valve 31 and metering valve 32, both of which are described in detail in U.S. Patent 5,009,244, are controlled by means of controls on a selector panel 30 forming part of control panel 11 discussed below. Also connected to three-way selector valve 31 through a conduit 39 is a refill pump 33 which supplies foam concentrate from a source 55 to bladder tank 42.

WATER/FOAM SUPPLY

Fig. 3 is an enlarged schematic drawing of that portion of Fig. 2 including the water and foam supply system, the differential pressure valve 17, the three-way selector valve 31, and the metering valve 32. Water under pressure from water pump 18 is supplied through check valve 68 to the differential pressure valve 17 where it is mixed with foam concentrate and discharged into conduit 41.

Foam concentrate in bladder tank 42 is supplied through a line 48 to the three-way selector valve 31. This valve 31 includes a manual selector for selecting one of three positions which are "foam", "refill" and "off". Water under pressure from water pump 18 is supplied through the differential pressure valve 17, conduit 50, three-way selector valve 31, and from there via line 46 to the tank 42 where it exerts pressure against the outside of bladder 44, forcing foam concentrate into three-way selector valve 31 via line 48 and to metering valve 32. During operation when foam concentrate is required, it flows through the three-way selector valve to the metering valve 32 which is graduated to supply the desired percentage of foam concentrate to water, such as 0.2% to 1%.

Differential pressure valve 17, which is best shown and described in Figs. 9-12 of

U.S. Patent 5,009,244, incorporated by reference herein and includes a pressure responsive internal plate and piston arrangement which senses the differential pressure between the high pressure at the inlet side of valve 17 and the lower pressure at the outlet side. This sensed differential pressure across valve 17 controls the proportioning
5 of foam concentrate to water irrespective of the rate of water flow through valve 17.

When a water/foam concentrate mixture is desired, metering valve 32 is set to provide the desired ratio of foam concentrate to water. Differential pressure valve 17 responds to water pressure from pump 18 via three-way selector valve 31 to vary the water pressure through conduit 46 against the outside of bladder 44. This causes foam
10 agent to flow through a line 48 to the three-way selector valve 31 on selector panel 30 discussed above. Foam agent in the selected proportion to water is metered in metering valve 32 which is adjusted to select precisely the desired proportion of foam concentrate to water irrespective of the volume of water flowing through differential pressure valve 17. Metering or proportioning valve 32 is shown and described in Figs.
15 6-8 of U.S. Patent 5,009,244 incorporated herein by reference. Foam concentrate in the selected proportion is supplied from metering valve 32 through a conduit 51 to differential pressure valve 17 where it is mixed with water. If only a foam/water mixture is desired, this mixture is supplied from differential pressure valve 17 through a conduit
20 41 of Fig. 2 to a water/foam solution port on the control panel 11 of Fig. 1 controlled by two-way valve 40 of Fig. 2.

WATER ONLY SUPPLY

If no foam is desired, metering valve **32** is closed and water is supplied from pump **18** through differential pressure valve **17** to conduit **41**. This conduit is connected to a two-way valve **40** on the face of the control panel **11**.

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COMPRESSED AIR/FOAM SUPPLY

When a compressed air/foam mixture is desired, valve **40** of Fig. 2 is closed and water/foam concentrate is supplied from the differential pressure valve **17** through a line **53** to a foam selector metering valve **58** (FSMV). This valve includes a plurality of orifices of different sizes, any one of which may be selected for controlling the volume of water/foam concentrate, which is mixed with the air supply. The foam selector metering valve **58** may have, for example, flow settings of 10 GPM (gallons per minute), 20 GPM, 40 GPM, and 80 GPM. More or fewer orifices and different orifice sizes may be chosen. The selected flow is then supplied to an air injection venturi **84**.

15 The foam selector metering valve **58** is shown in Figs. 4, 5, 6, and 7, and includes a body **90**, a shaft **92**, a disk **94** containing a plurality of orifices **94A, 94B, 94C, 94D, 94E**, and **94F.**, and a cover **96**. The shaft **92**, which is supported at one end in body **90**, and at the other end in cover **96**, carries disk **94**, which is secured to shaft **92** by means of a pin **98**, which seats in a slot **100** in disk **94**. A knob or handle **58a** on the 20 outside of valve **58** (See Fig. 7) turns the shaft **92**, which may be turned to align any of the several orifices shown between inlet passage **102** and outlet passage **104**.

Fig. 5 is a rear elevational view of disk **94** showing its several orifices **94A-F.** Slot **100** is shown in dashed lines indicating that it is not visible in this view.

Fig. 6 is a vertical sectional view through foam selector metering valve 58. In this view, shaft 92 is shown secured to disk 94 such that, by rotating disk 94, any of its several orifices may be aligned between inlet passage 102 and outlet passage 104. A pin 106 is shown urged into a detent 108 by a spring 110. There are several such 5 detents, one aligned with each orifice to hold disk 94 in the designed selected position.

Fig. 7 is a perspective view of the assembled foam selector metering valve 58. Visible in this view are the body 90, the cover 96, a knob 58a for turning shaft 92, and outlet passage 104. From the foregoing, it will be clear that by turning knob 58a to any 10 of several positions identified by feeling pin 106 drop into a detent, a desired orifice in disk 94 can be aligned with inlet passage 102 and outlet passage 104. Particular orifices identified as to flow rates may be identified by aligning an arrow on knob 58a with marked positions on the control panel 11, discussed below.

AIR METERING VALVE

As shown in Fig. 2, compressed air from compressor 52 is supplied over line 80 past a cut-off valve 82 to an air metering valve 54. The output of the air metering valve 54 is supplied to air injection venturi 84 where it is mixed with the water/foam concentrate from foam selector metering valve 58 and the compressed air/foam mixture is supplied through a conduit 60 and a two-way valve 38 for discharge as the output of a 20 compressed air foam system (CAFS) for fire fighting.

Valve 54, as best seen in Figs. 8 and 9, includes a plurality of orifices sized to supply air at, for example, 25 cubic feet per minute, 35 cubic feet per minute, or 50 cubic feet per minute at the known pressure. The air metering valve 54 is very similar to

valve 58. Fig. 8 is a vertical sectional view through air metering valve 54 and includes a cover 120, a body 112, a shaft 114, and a disk 116 containing a plurality of orifices of differing sizes, each corresponding to a specific volume of air supplied at a known pressure from the compressor 52 of Fig. 2.

5 Cover 120 contains an inlet port 122 and body 112 contains an outlet port 124. Disk 116 contains a detent 126 for each orifice position and is held in a selected radial position by means of a pin 128 urged into detent 126 by a spring 130. A knob, unshown but represented by the double-ended arrow in Fig. 8 is similar to knob 58a or a lever may be used to turn shaft 114 to align a desired orifice with inlet passage 122 and outlet 10 passage 124 to provide the desired volume of compressed air.

Fig. 9 is a cross-sectional view taken along line 9-9 of Fig. 8. Body 112 is shown containing disk 116 supported on shaft 114. Disk 116 is shown with four orifices and four detents 126, one of which is radially aligned with each orifice. Shown in dotted outline because it is on the opposite face of disk 116 is a pin 132 which sits in a 15 recessed slot 134. Pin 132 drives disk 116 radially when shaft 114 is rotated.

AIR INJECTION VENTURI

Fig. 10 is a vertical cross-sectional view through the air injection venturi 84. This unit provides two functions: it includes a venturi for injecting air into the water/foam 20 solution, and a spring-loaded check valve, which blocks water/foam flow until it reaches sufficient pressure to mix properly with the air. A poppet valve 136 in a housing 135 is urged against its seat 138 by means of a spring 140. An inlet passage 142 connects with a conduit 144 from the foam selector metering valve 58 (Fig. 2). The water/foam

solution crossing poppet valve 136 flows through a venturi 137, which includes a plurality of ports 145 at its throat which connect to air conduit 56 of Fig. 2. By creating a low pressure at the venturi throat, air is pulled into the stream of water/foam solution where it is combined to provide the desired mixture. The venturi outlet connects to 5 conduit 60.

Fig. 11 is a cross-sectional view taken along line 11-11 of Fig. 10. Compressed air from conduit 56 is supplied to an inlet port 150 where it enters a toroidal manifold 152 formed in venturi 137. Connected to manifold 152 are a plurality of passageways 154 leading to ports 145.

With both air and water pressure controlled and with the precisely sized orifices in both foam selector metering valve 58 and air metering valve 54, the ratio of water/foam to air remains fixed. There is no need for an operator to balance air and water/foam outputs with flow meters.

15 AIR ONLY SUPPLY

The system 10 can supply compressed air only from compressor 52 of Fig. 2 in the desired quantity as provided from the air metering valve 54. In this mode, engine E1 is shut off or declutched from pump 18, leaving no water pressure at foam selector metering valve 58. Air under pressure from air metering valve 54 flows through conduit 20 56, check valve 69, air injection venturi 84, conduit 60, and valve 38.

COMPRESSOR COOLING

The preferred air compressor **52** is of the oil flooded rotary screw type supplying air at a minimum of 50 cubic feet per minute of 125 psi at maximum engine RPM. The compressor **52** is driven by a toothed belt drive from the engine **E2** crankshaft. Water 5 flows through the heat exchanger **72** of Fig. 2 whenever the water pump is operating. The air compressor cooling system incorporates a thermostat that maintains the system oil temperature within a 168 to 225 degree range and is capable of maintaining recommended operating temperatures throughout the full operational range in ambient temperatures up to 115 degrees.

10 Unheated water from water pump **18** is supplied through a pipe **74** to a shell and tube heat exchanger **72** (HE) in Fig. 2 of all brass and copper construction. A pipe **75** carries cool oil to the lubrication system of compressor **52** where it is exposed to heat, warming the oil in the compressor **52**. The resulting heated oil then flows through a conduit **76** back to the heat exchanger **72** where heat is transferred to the unheated 15 water from pipe **74**. The heated water flows from heat exchanger **72** through a pipe **78** to tank **12**.

The compressor **52** is controlled by a pneumatic modulating inlet valve (not shown) mounted to the air end inlet. This controller senses air pressure and controls the air delivery of the air end while maintaining constant pressure.

20 In Fig. 12 is shown the control panel **11** of the universal fire fighting system **10**. All of the controls necessary for the normal operation in compressed air foam fire fighting are present including several gages and controls for routine monitoring and maintenance of the engines. Essential water, water/foam, and air controls shown have

been described above.

Near the upper left-hand corner of the panel **11**, there is a key operated ON/OFF switch **SW1**, a throttle **T1**, and a choke control **C1**, for an engine **E1** of Fig. 2, which drives water pump **18**. Part of engine **E1** may be seen through the cooling grid opening

5 **15.** The water pump engine **E1** is an internal combustion engine, preferably a 18 horsepower air cooled Briggs & Stratton Vanguard, 2 cylinder, 4-cycle gasoline engine, which includes an alternator and a 12 volt electric starter operated by key switch **SW1**.

Shown near the upper right hand corner of the panel is a throttle control **T2**, a choke **C2**, as well as an ON/OFF key switch **SW2** for air compressor engine **E2** partly 10 visible through grill **16**. The air compressor motor **E2** is conveniently located on a rear platform above the level of the hose fittings and wobble pump described below.

Upper center on the control panel are two gauges, air pressure gauge **20** and oil pressure gauge **22** for the compressor **52**. Below these two operational gauges are Hobbs meters **24** and **25**, which record running time for the two engines, **E1** and **E2**.

15 Two other key controls are present on the control panel **11**. They are the sub-panel **30**, which includes controls for the metering valve **32** of Fig. 2 and of U.S. Patent 5,009,244. The panel **30** includes the three-way selector valve **31** for foam proportioning with settings between .02% and 1%. The three-way selector valve corresponding to the selector valve of the foregoing U.S. Patent 5,009,244 appears on panel **30** as selector 20 **32**, which is movable to settings of Refill, Foam, and OFF. The next major control is a three-position turn handle for controlling the air pressure in air metering valve **54** located at the lower left immediately adjacent to the grid opening **15**.

A wobble pump **34** and primer control **35** are located at the lower right-hand area

of the control panel for priming the water pump 18 before commencing operations.

The control panel 11 has all of the water input and output lines and each includes one of the half-inch valves controlled by quarter-turn handles, all of which are shown in Fig. 2 in the "OFF" position. The four lines are water input line 27 controlled by valve 36
5 (suction), air foam discharge conduit 60 controlled by valve 38, water/water foam discharge conduit 41 controlled by valve 40, and water drain 43 controlled by valve 45.

The system is intended for primary operation with a local water tank, such as a 200-gallon tank 12, loaded on or near the same skid for the system, or a larger tank up to 1000 gallons, which may be transported with the system. Whenever the system is
10 intended to be used with another source of water, such as a hydrant line or by using the pump of the system to pull water from a stream or other source, the hydrant or other source is connected to the input line 27 and valve 21 is moved to its alternate position.

Also part of control panel 11 is the foam selector metering valve 58 which includes a valve or disc movable to one of four positions to control the volume of output
15 of water or water/foam mixture supplied from the system 10. The disc may be movable to select, e.g., 10, 20, 40, or 80 gallons per minute of flow supplied to output conduit 60. As shown in Fig. 2, branching from output conduit 60 is a separate conduit 62, connected to the hose reel 14 for supplying power to reel the hose in, as required. System drain 35 appears in Fig. 12 on panel 11 at the lower right. Certain minor
20 features, such as individual drains for draining the tank 42 and the pump 48 in freezing weather have not been illustrated.

Altogether, the system of this invention is believed to constitute a universal transportable fire fighting system of greater versatility than heretofore available.

The above-described embodiments of the present invention are merely descriptive of its principles and are not to be considered limiting. The scope of the present invention instead shall be determined from the scope of the following claims including their equivalents.

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